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Analysis of imaging equipments of human internal organs

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Abstract.
Medical imaging is an important tool in the diagnosis and monitoring of diseases affecting human internal organs. This work presents a comprehensive analysis of the various medical imaging equipments used to visualize human internal organs, including conventional X-ray machines, computed tomography scanners, ultrasound, magnetic resonance imaging, and multispiral computed tomography. The article examines the advantages and functions of each of these equipments.

Keywords:
X-ray
imaging equipments
multispiral computed tomography
dicom format
diagnostics

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In 1895, a remarkable discovery by a German physicist named Wilhelm Roentgen led to one of the most important medical advances in human history. X-ray technology has enabled doctors to see and examine the internal structures of the human body [1]. His main idea was to use X-rays. X-rays are a type of electromagnetic radiation that is widely used in medical imaging because of its ability to penetrate the body and create images of internal structures.

The use of X-rays requires special equipment and techniques to produce high-quality images. X-ray equipment is widely used in medical imaging to produce diagnostic images of the human body. The X-ray equipment includes an X-ray tube that produces a beam of X-rays, a detector that records X-rays passing through the body, and a computer system for processing the received images [2]. This work aims to analyze traditional X-ray equipments and digital radiography equipments.

A traditional X-ray machine uses X-ray film to take images. This type of X-ray imaging has several disadvantages, including the need for a darkroom to develop the images. This process is time consuming and the images cannot be easily manipulated. This in turn complicates the digitization process for storing and retrieving them.

Digital X-ray imaging is becoming increasingly popular due to its ability to produce high-quality images that can be easily manipulated and stored. A digital X-ray machine uses sensors to capture X-rays, which are then converted into digital images that can be viewed on a computer screen [3].

Currently, such digital X-ray equipments are becoming popular in Uzbekistan. In 2018, the Uzbek-Korean joint venture "Listem-Fergana" was established in the city of Fergana. This enterprise is the only enterprise in Central Asia that has mastered the production of digital X-ray equipments and supplies its equipment not only to the Republic of Uzbekistan, but also to the Republic of Kyrgyzstan. Currently, the company produces digital X-ray machines of the following models:

1. Digital X-ray equipment Listem REX-525R.

It is very popular among medical institutions due to its high productivity and excellent level of imaging. The Rayence digital flat panel detector provides high resolution images.

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Processing and displaying images takes more than 3 seconds.

2. C-ARM SM 25 HF UZ high-frequency mobile X-ray system.

Figure 1

Image taken with Listem REX-525R

It is used in surgery, urology, endoscopy, gynecology, orthopedics and cardiology examinations. It can hold the last image and has 8 image memory. Image rotation on the monitor screen, automatic monitor brightness control system, simple and intuitive operation of machine functions are the advantages of this equipment.

3. MOBIX-1000 UZ universal high-frequency mobile X-ray machine.

It can take all the images with normal power without charging the battery, and it has a light and compact structure.

Table 1

Information about the PLD 5600A X-ray imaging equipments

The purpose of the X-ray imaging equipments	Image processing functions	Information about the display
It is used in the analysis of diseases of the gastrointestinal tract and in orthopedic, pediatric, chest, urinary system angiography, peripheral angiography operations and many other examinations.	Select an image; magnification; cutting; negative image; horizontal, vertical twist; delete image; rotate counterclockwise/clockwise; distance measurement; measure the angle; left / right size; window width and location; image enhancement;	Screen size: 19" (48 cm) Type: LCD, black and white Resolution: 1280x1024 Maximum brightness: 1000cd/m

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In addition, there are X-ray imaging equipments that are imported and used from foreign countries. An example is the PLD 5600A high-frequency digital gastrointestinal and DR X-ray machine manufactured by the Chinese company Perlove.

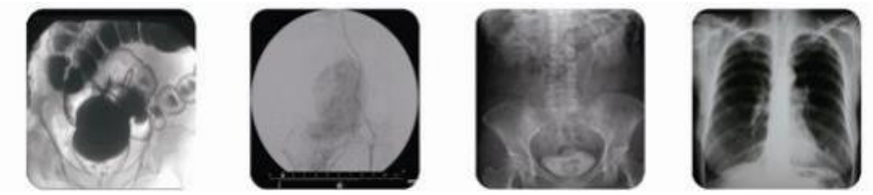

Figure 2
An image taken with the PLD 5600A X-ray machine

Table 2

Information about the Lanmage 7500 X-ray imaging equipment made in China

The purpose of the X-ray imaging equipment	Image processing functions	Information about the display
It is used in taking x-rays of the chest, fluorography of hard tissues, bones and lungs, respiratory organs, degenerative-dystrophic (osteochondrosis, spondylosis) x-rays.	Automatic window width adjustment, grayscale adjustment and parallel display of several images. Zoom in, zoom out and point zoom, rotate left/right, up/down, image filtering: noise reduction, contrast, and more. Measure distance, angle and rectangle. It supports standard Dicom 3.0 function, it can transmit data to other stations.	Console processor i7-4790 RAM - 8 GB Hard disk - 1 TB The screen size is 21.5 inches Resolution - 1920×1080

It is also possible to take an X-ray image in 3D. Computed tomography is used for this. uCT520/uCT528 is a computed tomography X-ray equipment designed to produce cross-sectional images of the body. Creates a 3D image based on X-rays taken at different angles and planes and transmitted to the whole body (including the head, neck, veins). The uCT 528 requires a minimum installation area of 9 m². Based on

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the anatomical data, it creates an optimized 3D dose distribution plan, which significantly reduces the patient's radiation dose.

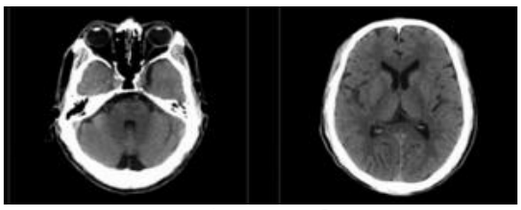

Figure 3
uCT520/uCT528 computed tomography image

Multispiral computed tomography (MSCT) is one of the most innovative and effective diagnostic methods in modern medicine. It provides doctors with detailed information about a patient's internal organs, tissues, and structures, allowing for early disease detection and more accurate treatment planning. MSCT emerged as a result of developments in the field of X-ray tomography. The main principle of MSCT is the use of X-ray radiation passing through the patient's body and subsequent processing of the obtained data with the help of computer algorithms.

Modern MSCT scanners are characterized by high resolution, shutter speed and the ability to capture three-dimensional images in real time. They also have the ability to see different tissues with the help of contrast agents, which significantly increases the accuracy of the diagnosis. The advantages of MSCT are high information content, non-invasiveness, the ability to obtain information about various body systems and the ability to detect even small pathological changes. It is used to examine the head and neck, chest, abdomen, pelvis and extremities. MRI is an important eqipment for diagnosing a variety of diseases, including tumors, infections, trauma, bleeding, and vascular disease.

Below is information about the 128-slice MSCT scanner and its features:

- high clarity and accuracy;
- reduction of operational costs, high-speed operation is achieved through the rational use of advanced clinical technologies;

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- IHD (isotropic high definition) technology allows to achieve a high resolution of 24 lines/cm with minimal exposure to radiation;

- By combining the Quad-Sampling technology with the new Micro-STAR detector, an excellent image is obtained;

- When radiation exposure reduction algorithms are used together with advanced CardiacImaging algorithms, the exposure to the patient can be up to 1 mSV;

- A powerful workstation allows to quickly and efficiently process large amounts of data and make images better;

Exclusive Quad Sampling and Micro-STAR detector provide high resolution images. It can support 1024 × 1024 reconstruction matrix when creating high-resolution images, which has a much higher resolution than the common 512 × 512 matrix.

ClearView: An advanced iterative algorithm for two spaces, one for the raw data space and one for the image space. With three levels of Slight, Standard and Ultra, you can get excellent image quality at a lower dose.

Information about the equipment is given below:

– Number of projections per detector array: Up to 4640 projections per rotation.

– Spiral scanning allows for multiple adjacent layers to be acquired while simultaneously moving the table during scanning. The maximum exposure time is 100 seconds.

– Axial scanning allows simultaneous acquisition of up to 128 slices with sequential table movement between scanners.

– Image processing. Main functions: zoom, move, invert, show image parameters. 2D View, (MPR), (CPR), (MIP), (MinIP), (AIP), 3D Shaded Surface Reconstruction (SSD).

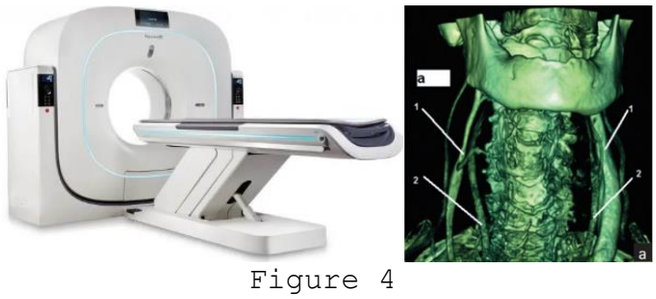

Figure 4

MSCT medical equipment and a sample of the image taken in it

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Magnetic resonance imaging (MRI) has revolutionized medical diagnostics by providing non-invasive and detailed images of the human body. It is an advanced imaging technique that uses strong magnetic fields and radio waves to create detailed images of the human body.

Figure 5
Oasis 1.2T MRI medical equipment and a sample of the image captured in it

Ultrasound examination (UTT, UZI, Sonography) is a non-invasive (non-surgical) method that uses ultrasound to determine the localization, morphology, functions and condition of organs, and the structure of hearing. This method of examination is the most convenient, harmless, quick, and invaluable in making an accurate diagnosis. Below is information about the MyLab X8 eXp ultrasound medical equipment, one of the most used equipments:

The MyLab X8 eXp ultrasound medical equipment is an expert-class stationary scanner with next-generation digital and medical device technologies for all types of clinical examinations. It has the following features:

- 21.5 inch Full HD LCD monitor;
- 5 active sensor ports;
- 10.1-inch touch screen;
- battery life 60 minutes.

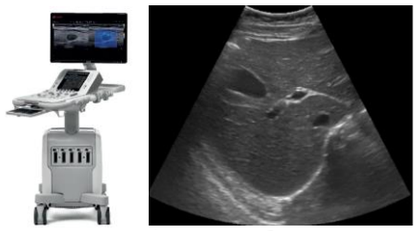

Figure 6
MyLab X8 eXp stationary UZI medical equipment and a sample of the image obtained in it

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Above is an analysis of the means of imaging human internal organs. When medical images captured by these imaging equipments are processed and analyzed on a computer, it is also important to know the format of these images.

In imaging, file formats are important for annotating medical images. The file format describes how the image data is organized within the image file and how the pixel data should be interpreted by software to correctly load and visualize it. Below are some medical image formats:

DICOM - Widely used format for medical imaging. Supports X-ray, MRI, CT and several other medical imaging methods. Used for archiving and sharing medical images.

NIfTI -Designed to store and share brain imaging data, supports 3D data.

Analyze-Dastlab was originally developed to analyze brain images, supports 3D and 4D data, and is used for research and analysis in various medical fields [4].

MINC supports multiple modalities such as CT, MRI and PET scans, used for research and clinical analysis.

The choice of medical image file format depends on the imaging method, the intended use of the images, and the software used to analyze the image.

Conclusion

This research paper provides information on x-ray imaging equipments, including conventional and digital x-rays, computed tomography, and MSCT, and reviews medical image file formats. Among these equipments, digital X-ray and computer tomography equipments are widely used today.

Mobile equipments developed by the company "Listem-Fergana" in Uzbekistan allow taking X-rays at the location of the patient. This increases the quality, productivity and speed of medical care, which is very important in the examination of critically ill patients. Another advantage of these equipments is their low cost.

Currently, researchers are constantly working on improving MSCT technology. One of the promising areas of development is to reduce the dose of X-ray radiation to minimize the risks for patients. Also, research is being conducted to develop new data processing algorithms, improve image quality, and increase diagnostic efficiency.

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Adherence to standard file formats ensures compatibility and correct image storage, which is essential for correct diagnosis and treatment in modern medicine. Almost every equipment used in radiology today (including CT, MRI, ultrasound and radiography) is equipped with support for the DICOM standard. It enables the transfer of medical images between equipments from different manufacturers and facilitates the development and expansion of image archiving and communication systems.

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